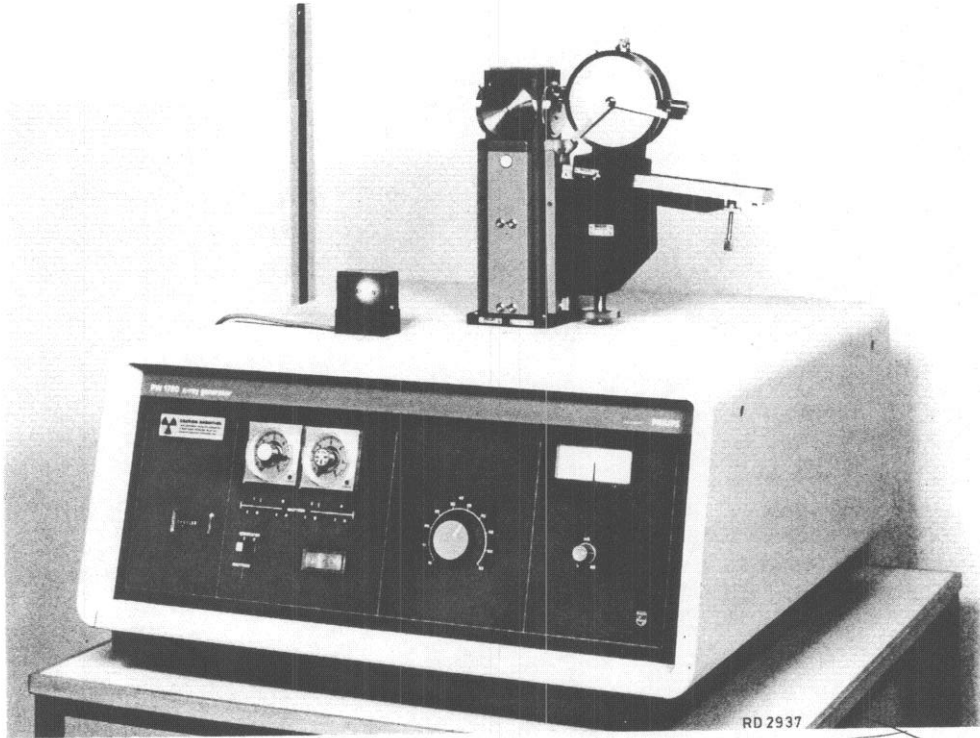


# PHILIPS

UC # 78-10-02710



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Table-top X-ray Generator  
PW 1720

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Milpitas, CA 95035  
#408-263-7000

Instruction manual



Frank Stein  
TECHNICAL info

### 3. OPERATION

This paragraph describes the method of operating the PW 1720 and the options, such as timers etc., but does not include operating instructions for accessory devices such as cameras and vertical goniometers.

The initial installation of the PW 1720 is described in the Service part of the manual.

#### 3.1. INITIAL CHECKS

Before switching on the generator, check the following:

- Check that HT tank transport fixing screw is removed, see Service installation section.
- Cooling water for the X-ray tube is turned on.
- The tube shield is fixed in the required position (0°, 45°, or 90°).
- The X-ray tube installed is suitable for the analysis program.
- The kV and mA controls are in minimum position (10 kV and 5 mA), also refer to paragraph 3.6.
- The PW 1161 X-RAYS ON lamp (if fitted) is correctly wired, and is placed in a conspicuous position.
- The timers (if required) are installed.
- The accessory units, required for the analysis program, are correctly fitted to the tube shield.  
The white push-button must be depressed by the accessory, and the shutter disc is rotated to allow the X-ray beam to pass.
- Set the filter disc to the desired position.
- Check that the a.c. mains stabiliser is correctly installed, when required.

#### 3.2. SAMPLE ANALYSIS

The procedure for analysis will depend on the accessories being used, and the operation of these devices is described separately in the respective manuals. They should be made ready for analysis by loading the sample, film (etc.), or positioning the goniometer or other device -see also paragraph 3.4.

- 1 Momentarily operate the GENERATOR I push-button, and when the safety circuit is complete the X-RAYS ON lamp(s) will light to show that X-rays are being generated. The lamp in the push-button is also lit.
- 1 Increase the kV control to the required value, then adjust the mA control until the desired X-ray tube current is indicated by the meter. Do not exceed the rated maximum power to the X-ray tube, i.e. the setting of kV and mA must not exceed the values shown for X-ray tubes in Appendix 1. The ratings shown in the "X-ray diffraction tubes" leaflet (9499 300 10311) are not applicable.
- 1 Determine the exposure time, and set the timer if fitted - also refer to paragraph 3.3.
- 1 Place the SHUTTERS three - position switch to select the desired window shutter (with timer), or infinite time (middle position).
- 1 Open the shutter by simultaneously pressing the lowest SHUTTERS push-button, and the SHUTTERS I push-button corresponding to the window shutter which is to be opened, refer to figure 3.1. The shutter will remain open until the timer exposure time has elapsed, or until the SHUTTERS 0 push-button is operated (when a timer is not fitted or used).  
During the time that the shutter is opened, the X-ray beam is allowed into the camera or goniometer, the red lamps on the tube shield below the shutter/filter disc are lit, and the red flags will appear in the side holes of the cover over the tube shield mechanism. In the event of a failure of one of the lamp bulbs in the tube shield, the shutter is closed immediately.

When the shutter is closed the generator will switch off, unless another shutter is still open in one of the other tube shield positions. Alternatively, the generator can be switched off manually by operating the GENERATOR 0 push-button. All lamps will extinguish. Before the generator is switched off the power to the X-ray tube should be reduced, by first turning the mA control to minimum, and then the kV control. Any generation of HT will be inhibited if the shutter does not fully close after a close shutter command.

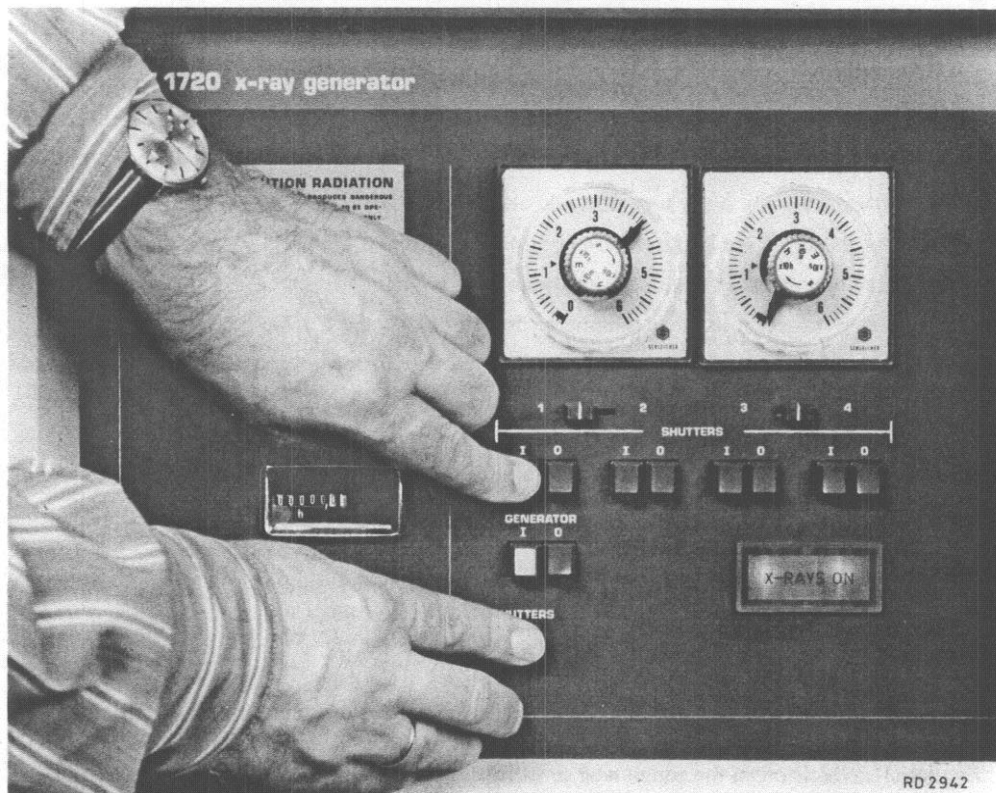


Fig. 3.1. Opening the window shutter.

### 3.3. SHUTTER CONTROL

For camera work it is usual to control the exposure time of the film to X-rays by using a PW 1722 timer. Two timers can be fitted: the left-hand timer will control the shutter of either window 1 or window 2, and the other timer the shutter of window 3 or 4. This paragraph describes the automatic and manual control of the shutter operation.

When the camera is installed on its bracket in front of the required exit window of the tube shield, open the shutter disc and push the camera forward until the collimator enters the hole in the disc. Ensure that the microswitch button on the tube shield is actuated by the pin or arm of the camera.

**NOTE:** *The space between the front of the collimator and the exit opening of the tube shield should be kept as small as possible to ensure that radiation does not escape. Take care that the filter disc is free to move, and is not damaged.*

### 3.3.1. With timer control

Operation, using a timer, is as follows:

1. Check that generator kV and mA settings are correct.
2. Determine the exposure time, and set the timer for the required window shutter. The clear plastic cover is rotated until the black pointer is set to the required time (0 to 6), while the centre knob is rotated in a clockwise direction until the required multiplication factor (x1, x10 : seconds, minutes or hours) is against the arrow.  
When timing commences the red pointer will gradually return to zero, then the timer microswitches return to the normal position (off), the timer and the red pointer returns to the position set by the black pointer.
3. Set the three - position SHUTTERS switch to select the required window shutter, e.g. when window 3 is to be used the right-hand switch is set to 3; and the time must be set by the right-hand timer.
4. Open the shutter by operating the lowest SHUTTERS push-button simultaneously with the required SHUTTERS I push-button. When the shutter is open the X-ray beam passes to the sample in the camera, the red lamp on the tube shield (below the filter/shutter disc) is lit, the red flags will appear in the holes on either side of the tube shield, and the timer operation will commence.
5. When the preset time has elapsed the shutter is closed, and the whole instrument is switched off unless a shutter is open at another tube shield position. X-rays will be generated as long as one or more shutters are open.

*NOTE: The red warning lamps are fail safe, and the shutters will close if a bulb filament is broken when a shutter is open.*

### 3.3.2. Without timers

When a timer is not used, or is not fitted, proceed as follows:

1. Check that the generator kV and mA settings are correct.
2. Ensure that the 3 - position switches are in the mid-position.
3. Open the shutter by operating the lowest SHUTTERS push-button simultaneously with the required SHUTTERS I push-button. The shutter will open and the X-ray beam passes to the sample in the camera, the red lamp on the tube shield is lit, and the red flags will appear in the holes on either side of the tube shield.
4. When the exposure time has elapsed, operate the SHUTTER 0 push-button. The shutter will close, and the generator will switch off unless a shutter is open at another tube shield position. X-rays will be generated as long as one or more shutters are open.

### 3.4. SWITCHING OFF A MOTOR WHEN THE SHUTTER CLOSES

Cameras can be fitted with motors, either for moving film, or a crystal, or for spinning the sample. If required. the motor operation can be switched off when the timer reaches its zero position, and it will remain off until the timer is reset (if one or more shutters are still open). The two outside a.c. mains sockets on the rear panel are used for this purpose, and it is necessary for a jumper wire to be removed between terminals 25 and 26 on the rear of the timer, refer to the Service Part.

The mains connector for the motor used in the tube shield position 1 or 2, must be plugged into the mains socket immediately behind, i.e. adjacent to the left-hand side panel. A motor used for positions 3 or 4 will be connected to the left-hand socket on the rear panel (viewed from the rear).

The procedure for analysis is as described in paragraph 3.3.1., but now the camera motor will start at the moment that the Starting relay operates, when GENERATOR I is depressed.

When the shutter is opened the timer will start, and at the end of the preset time when the shutter closes, the motor will also stop. If another shutter is still open the equipment will not switch off, the timer is not reset and there is no power to the motor.

To reset the timer and start the camera motor, place the three-position switch in its central position. If all shutters are closed after the preset time, the equipment switches off and the timer resets.

### 3.5. USE OF WINDOWS

The tube shield on the PW 1720 has a window on each of the four sides, see paragraph 2.2.

The exit of X-rays is prevented by a blank shutter disc, or by a rotating shutter disc whose exit hole should only be positioned at the window when a camera or goniometer is correctly fitted. In addition, there is a shutter controlled by an electromagnet, which can only operate when a safety circuit is complete, and when two push-buttons are operated simultaneously.

The windows are in pairs and opposite windows have a similar X-ray beam configuration. Owing to the short distance between anode and cathode (filament) of the tube, and the high voltage between these two electrodes, there is an almost linear electric field between the two, and the photon emitting area on the anode is more or less identical to the shape of the filament.

The filament has a rectangular shape but the size depends on the type of X-ray tube

Focal sizes are:	Fine focus	= 0.4 x 8 mm
	Normal focus	= 1 x 10 mm
	Broad focus tube	= 2 x 12 mm

Two windows in the metal body are parallel with the long side of the focus: the two other windows are at right angle to it. The windows are at the same height with respect to the anode plane, and they allow beam take-off angles between  $0^\circ$  and  $12^\circ$  with respect to the anode plane. At the usual accepted take-off angle of  $6^\circ$  ( $\sin 6^\circ$  and  $\tan 6^\circ \approx 0,1$ ), the focus dimension in the direction of the relevant beam becomes 0,1 of the original dimension.

The result is that on two sides a sharp line appears (line focus) and on the other two sides a bright focal spot (point focus). with specific dimensions for the various types of X-ray tube. One of the point focus is on the same side of the tube as the sealing stem, This provides the identification mark for the focal spots, see figure 3.2.

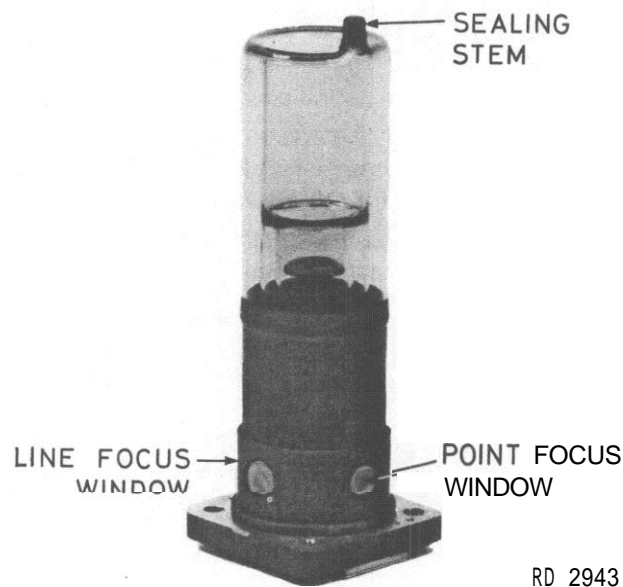


Fig. 3.2. X-ray tube showing windows.  
NOTE: do not touch beryllium windows.

Typical window applications are shown below:

Line focus

Powder diffractometer  
Guinier camera

Point focus

Debye - Scherrer camera  
Texture goniometer  
Laue camera  
Weissenberg camera  
Precession camera  
Reciprocal lattice explorer

### 3.6. CHANGING THE X-RAY TUBE

To change the X-ray tube, proceed as follows:

1. Switch off by pressing the GENERATOR 0 push-button.
2. Turn off the water supply.
3. Drain water from the instrument by opening the air inlet valve next to the water inlet and outlet connections, and wait until air has filled the system. Some water may run from the air inlet valve.
4. Loosen the two captive screws at opposite corners on the top of the tube shield. The X-ray tube should be removed by lifting upwards, when handling the X-ray tube take care to hold by the metal base and **DO NOT TOUCH THE BERYLLIUM WINDOWS**. These windows are thin, and can be poisonous to the skin. Do not remove the X-ray tube if generator operation has been switched off because of a failure (safety circuit actuated) see Service section.
5. Select the new tube and insert into the tube shield, after first checking the condition of the "O" rings for the water tubes. There is a locating pin on the top of the tube shield to ensure correct positioning of the tube. Tighten the two fixing screws.

**NOTE:** The tube shield is designed to accept X-ray tubes with dimensions as figure 3.3. version A. For other tubes a spacer ring, such as PW 1043, will be necessary when the dimension from the underside of the tube base to the centre of the tube base to the centre of the tube window exceeds 21 mm. Note that dimension "a" must not exceed 120 mm.

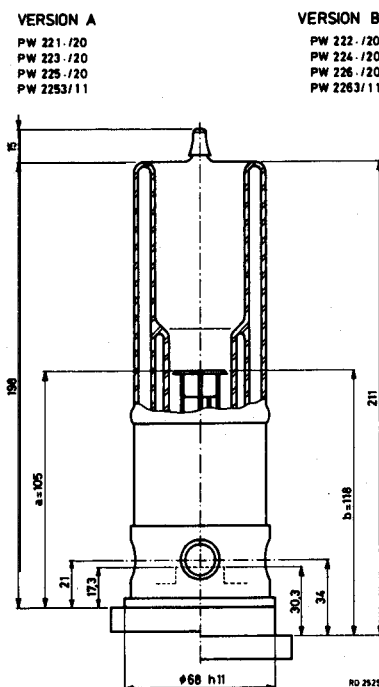


Fig. 3.3. X-ray tube dimensions.

6. Change the filament voltage supply, if necessary, depending on the type of focus.  
A fine focus tube should have a filament voltage of 8 volts, and broad and normal focus tubes require 10 volts. On later tubes the type of focus is indicated, and in other cases consult the tube instruction card.

To change the filament voltage, switch off the unit, open the right-hand side panel by loosening the two Allen screws.

The panel is hinged at the bottom. Behind the front panel is a switch marked BF (broad focus) and NF FF (normal/fine focus). Select as required.

Close the cover.

7. Close the air inlet valve, and turn on the water supply.
8. Turn the kV and mA controls to the minimum position, and operate the GENERATOR I push-button.
9. When an X-ray tube is new, or has not been used for a week or more, the following procedure should be followed:  
Check that the mA meter reading is stable, then slowly increase the kV control to 30 kV, over a period of one minute. Slowly increase the mA control watching for signs of instability of the mA reading.  
**DO NOT EXCEED THE RATED kV AND mA VALUES, as shown in Appendix 1; disregard the instruction card values (X-ray diffraction tubes).**  
Slowly increase the kV to the required operating high-voltage, at the same time adjusting the mA reading so that the maximum power to the tube does not exceed the rated limits. If the mA meter reading shows any sign of instability the kV should be reduced, and held at a lower value for about a minute before attempting to advance the kV control again.

### 3.7. POSITIONING THE TUBE SHIELD

The tube shield can be placed in one of three orientations on top of the generator, i.e. so that the X-ray beams make angles of either 90° or 45° or 0° to the front of the generator.

However, the rotation of the tube shield must not be more than 90° in either direction from its original position. Since the line and point focus beams are 90° apart it is possible to place the tube shield with either beam in any position depending on the use of the generator, or personal preference.

The tube shield is fixed to the table top by means of four Allen screws. Remove the screws and rotate the tube shield carefully, simultaneously ensuring that the cables and water hoses inside the cabinet are not unduly tensioned. For this purpose open the left-hand side panel of the generator cabinet, and observe the hoses and cable. Refix the tube shield on the table top with the screws, and close the side panel.

### 3.8. DIFRACTOMETRY OPERATION

The generator will normally be used to obtain the simultaneous (photographic) registration of reflections from a specimen, therefore, stabilisation of the X-ray tube voltage is not necessary.

A PE 1612 a.c. voltage stabiliser can be used in the mains supply to the generator, when an improved stabilisation is required for more accurate powder diffractometry.

This voltage stabiliser is specially designed to provide a stable mains voltage to small units, such as the PW 1720 X-ray generator. Variations in the mains voltage from -15% to + 10% will be stabilised so that the output voltage variation is better than 0,1%. A full specification is given in the operation manual of the PE 1612 a.c. voltage stabiliser.

A PW 1050 vertical goniometer with stepping motor or with synchronous motor can be installed on top of the generator, and two mounting holes are provided in the top cover, see figure 3.4. Refer to the PW 1349 "Diffractometer kit" instruction manual, for alignment information.

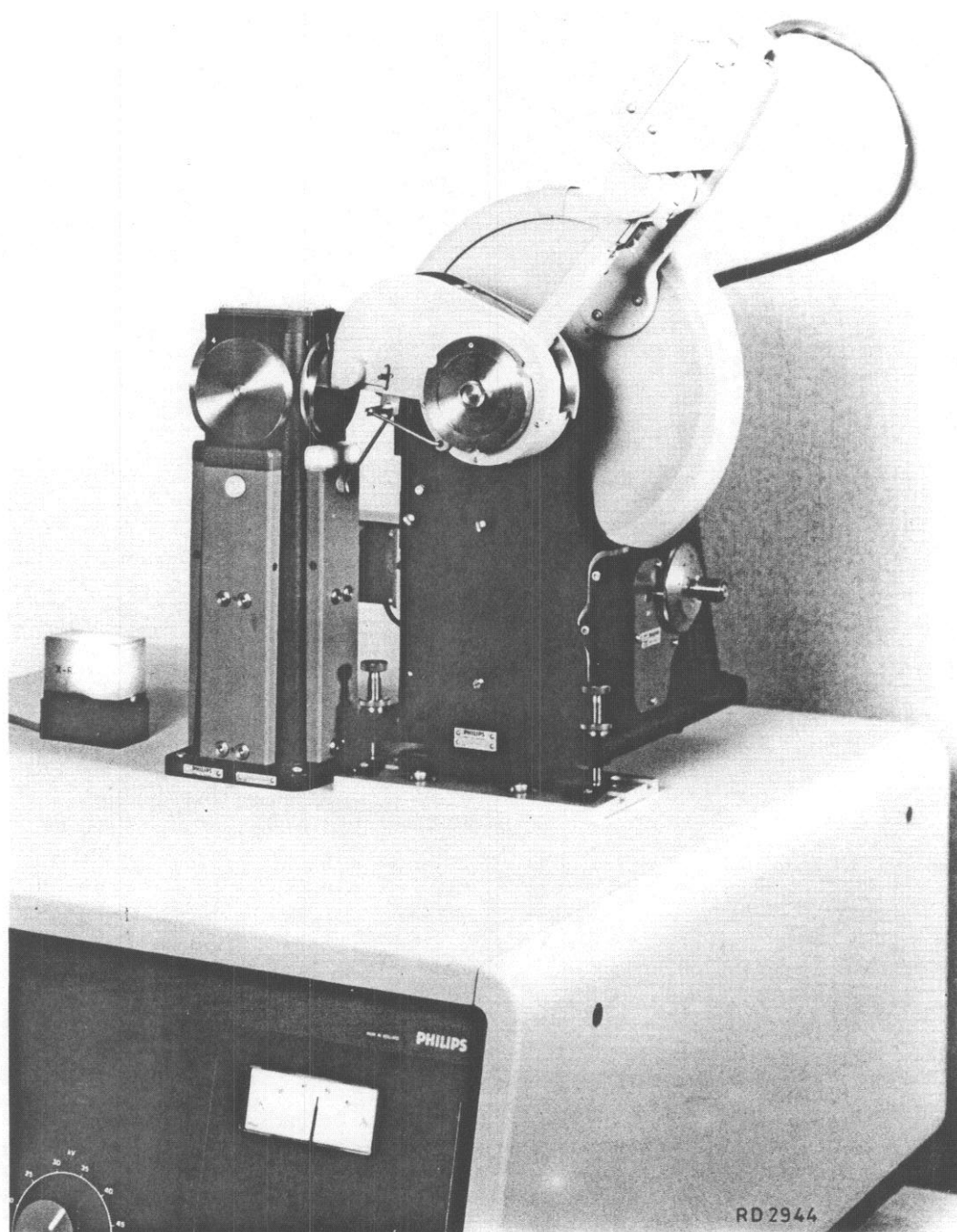


Fig. 3.4. PW 1720 with vertical goniometer.